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ABSTRACT

Subjects ranging from preschoolers to professors were asked to choose between pairs of stimulus pseudowords, the one most like a given target word. Unidimensional scale analysis, item analysis, and factor analysis of the data resulted in the following findings: (1) Adults showed a dominant preference to "addition" errors as opposed to errors of changes in letter order. (2) Preschoolers showed a definite lack of preference; those who did show some consistent choice behavior preferred the letter order distortions. (3) The fourth graders had almost reached the preference position of the adults. (4) Half of the second graders were approaching the adult pattern of preference. (5) Poor readers in third and fourth grades were less consistent than better readers in preference choices; they also tended to take a more letter dominated view of similarity. (6) College seniors preferred the second error-word significantly more often than did the elementary children. And (7) Variability of preference between subjects within a group decreased as age increased. On the whole, this study indicated a continuous development in reading styles from a "separate letter conscious" view of words to an emphasis on a "connected letter order" view of words as the reader matured. Tables, figures, appendixes, and references are included. (AW)

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ANALYZING THE DEVELOPMENT OF READING SKILL USING AN ERROR-WORD PREFERENCE INVENTORY

by

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Introduction

This study presents an Error-Word Preference Inventory and analyzes responses of school children and adults to the instrument. The subject is asked to choose, between pairs of stimulus pseudo-words, the one most like a given target word. If, for example, the target word is case the subject is asked to choose which of two error-words, oase or acse, looks most like case.

Preschool subjects show a preference for error-words having the same letters as the target word even when such letters are radically permuted. Adults, however, prefer error-words whose letter order remains unchanged even though specific letters may be added to, altered in, or omitted from the error-words. A preschooler, for example, chooses emos as most like the target word some while an adult prefers the pseudo-word ssome. Other groups' preferences for word-errors fall between these extremes.

The group responses to the Inventory indicate a continuous development. Their preference profiles suggest that reading skill is a

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development that begins in a "separate letter conscious" approach to word perception and ends with an emphasis on a "connected letter order" view of words.

The Problem

The need for effective diagnostic tools in the measurement of reading problems among young children seems imperative. A general diagnosis of reading difficulty is usually determined by the fact that a child has achieved very deficient results in reading and spelling in relation to his other school grades. The diagnostic problem is more acute, however, for pre-readers and beginning readers since there are few measures at this age level in any areas of achievement which may serve as a baseline for making comparisons. For young children it appears particularly important to differentiate a prognosis of late blooming from that of a specific disability. This would allow remedial measures to be taken before the child's reading problems become masked by emotional ones.

The tools utilized in diagnosing language disability have primarily consisted of The Wechsler Intelligence Scale for Children, The Bender Visual Motor Tests, The Benton Visual Memory Test, The Kephard Perceptual Rating Scale, The Screening Tests for Specific Language Disability, The Gates-McKillop Diagnostic Reading Test, and The Hoyt Clymer Silent Reading Diagnostic Tests. Most of these instruments can reveal general indications of language disability. None, however, provides any sign or group of signs that distinguishes among specific kinds of reading disability.

Such instruments fail to provide specific information of the visual-cognitive strengths and weaknesses within the young child which affect his ability to identify words. Schiffman (1962) stated that solutions

to the complex problem of diagnosing specific reading difficulties lay in refining diagnostic techniques and Money (1962) also indicated a need for new tests that are more accurate and valid in the differential diagnosis of reading disability. Shedd (1968) implied the need for more rapid screening procedures which could be employed by nonspecialized personnel.

Theory and Review

Both children and adults have been observed to misperceive words when reading. Most often some other word is substituted for the original. Word substitution errors due to visual misperceptions can be classified into natural groups. If, for example, the word stop is perceived as slop, this perceptual error (as substitution of t for l) is naturally classified as a substitution error. On the other hand, if stop is perceived as pots, this is classified as a reversal of the letters. The words bat and pat are sometimes confused, by beginning readers, and the letters of these words are also seen as highly similar. The confusion between bat and pat, however, is a special kind of substitution error which results because b and p can be made to coincide by rotation.

Money (1966) has illustrated major types of visual perception errors that are characteristic of visual reading problems and presented several classifications under each type. Lecours (1966) has presented a morphology of misspellings which occur among retarded readers. The present author has devised a more extensive taxonomy of possible word confusions on the basis of letter order, letter substitution, word change, or combinations of these factors. The taxonomy with examples is given in Table 1.

The geometrical similarity between lower case letters of the English alphabet has been investigated (Dunn-Rankin, et al., 1968) and in addition

the work of Popp (1963) and Dunn-Rankin (1969) has provided an empirical basis for determining the similarity between lower case letters of the English alphabet. These studies provide a strong rationale for choosing letters which fit the substitution category of the Taxonomy given in Table 1.

Basic to the formulation of such a taxonomy is the idea (Carroll, 1964) that a word can be visually constituted as the sum of its parts. The parts in this case are hypothesized to be the letters that form the word. Two words, therefore, with highly similar letters should be misperceived for each other more often than words whose letters are not as perceptually congruent. The words mouth and month or beam and bean are configurally very similar because the letters that form the words are highly similar.

A basic assumption behind the use of similarity judgments to diagnose reading is that judged similarity is related to visual confusions. The "more similar" choice should have a greater probability of being misperceived for the target when other factors such as frequency of usage, phonetic similarity, and context are held constant. Therefore, if a subject has a choice between two kinds of error-words, his choice should also indicate the kind of visual organization he utilizes when attempting to read.

Another assumption in building a diagnostic measure of reading disability is that problems in the visual recognition of words are not evenly distributed across subjects. Presumably different children suffer different types of misperception. Wolfe (1939), for example, found differences between subjects in their response to partial and complete reversals, and illustrated that to some children partial reversals were confused more often than complete reversals.

TABLE 1

TAXONOMY OF POSSIBLE ERRORS ASSOCIATED WITH THE VISUAL PERCEPTION OF WORDS

ERROR TYPES	EXAMPLES
Letter Order	
a. Simple reversal	saw-was; pot-top
b. Single letter permutation	
1. Beginning	door-odor; scar-csar
2. Middle	trial-trail; scared-sacred
3. End	east-eats
4. First to last	spot-pots; spin-pins
Letter Substitution	
a. Letter rotation	
1. Beginning	pig-big; war-mar
2. Middle	month-mouth; ladle-lable
3. End	tap-tad-tab; beet-beef
4. Multiples	fad-tab; mat-wet
b. Letter misperception	
1. Beginning	not-hot; eat-cat-oat; kind-hind-bind
2. Middle	jelly-jolly; jetty-jolly; all-ail
3. End	tan-tam; hale-halo
4. Multiples	leggy-foggy;
Word Change	
a. Addition	
1. Beginning	in-tin
2. Middle	met-meet
3. End	mad-made
b. Deletion	
1. Beginning	those-hose
2. Middle	may-my
3. End	soon-so
Combination of Major Errors	
a. Simple reversal and misperception	net-ton; liar-nail
b. Simple reversal and letter rotation, etc.	tad-bat; war-ram

A review of the literature indicates that the early diagnosis of specific visual reading disability is an important problem. The author accepts the proposition that visual errors associated with letter and word recognition can vary widely, and suggests that the relative frequency of various visual perceptual problems are not the same for normal children and children who display symptoms of reading disability.

It is suggested that the differential diagnosis of visual reading problems may be accomplished by creating instruments which have subjects make similarity judgments between a target word and word pairs displaying different kinds of errors. The analysis of relative performance in these visual recognition tasks should allow teachers to focus instruction more effectively, and comparison with normal responses on such a measure should provide a baseline for the diagnosis of specific reading disabilities.

Method

The Error-Word Preference (E-WPI) Inventory was constructed by choosing items which represent the major categories illustrated in the Taxonomy of Word Similarities, Table 1. The categories used were Letter Order, Letter Substitution, and Word Change. Seven kinds of errors in these categories were used:

Category	Error	Definition
Letter Order:	Reversals (REV)	Reverse entire word.
	Permutations (PER)	Transpose adjacent pr. of letters.
	First-to-Last (F-L)	Move first letter to end of word.
Letter Substitution:	Rotation (ROT)	Rotate individual letter.
	Misperceptions (MIS)	Change individual letter to similar appearing letter.
Word change:	Additions (ADD)	Repeat a letter.
	Deletions (DEL)	Delete a letter.

Each form of the inventory (see Appendix A) contains 21 different familiar target words and 21 pairs of error-words which are distortions of their respective targets. The seven types of errors are used to form the pseudowords by permuting, substituting, or changing the letters of the target words. The seven errors were paired in all possible ways with each pair matched against its appropriate target. For example:

linc (Misperception)

(Target word) line

enil (Reversal).

The 21 different pairings were arranged according to procedures developed by Ross (1934).

The three forms shown in Appendix A differ primarily in the position of the error embedded in the pseudoword. In the first form the error occurs at the beginning of the pseudoword, in the second form in the middle, and in the last form at the end of the word. The target words are all four letters long. They were taken from Rinsland's (1945) word list and are among the most common words used in writing. Words were particularly chosen that adapted themselves to embedding the seven specific errors. When letter substitutions were made, letters were chosen which had been shown to be highly similar (Dunn-Rankin, 1969). The letter m was substituted for w (a rotation) and the letter c was substituted for e (a misperception), for example.

The forms were administered with the oral directions "Circle one word of each pair that looks most like the single word." For pre-school children each item was placed on a separate two by three inch card and the items were individually administered over a three day period, one complete set of pairs for each day. All other subjects responded to the three forms at one sitting.

The instrument was administered to the following groups of individuals in the state of Hawaii during the school year 1969:

52 Professors, graduate students and secretaries, at the University of Hawaii.

30 College Seniors in a Tests and Measurements Class at the University of Hawaii.

45 Fourth grade students attending Hahaione Elementary School.

37 Third grade students attending Hahaione Elementary School.

25 Second and Third graders attending Hahaione Elementary School.

49 Second grade students attending Hahaione Elementary School.

12 Preschool children attending the University of Hawaii Preschool.

25 Seventh grade remedial reading students at Radford Junior High School.

8 Clinical cases attending the University of Hawaii Reading Clinic.

Little difficulty was experienced by most of the subjects in making the relative comparisons offered in the (E-WPI). Most subjects completed the three forms in less than ten minutes.

Unidimensional Scale Analysis

For each subject three profile rank scores, one for each form, and a total profile over the seven error categories were computed(for computer program, see Dunn-Rankin, 1965). For each group, unidimensional rank order scale scores of error preference were calculated (for method of computing scales, see Dunn-Rankin, 1969). Appendix B presents the scale scores of each group of subjects. Because of inter-correlations (see Appendix B) between the group scale scores within the elementary school population

and within the adult population were high (greater than .90) grades 2, 2-3, and 3 were aggregated, and adults and college seniors were also combined. This resulted in four normal groups of subjects; (1) preschoolers, (2) 2nd and 3rd graders, (3) 4th grade students, and (4) adults and seniors.

The normal group's scales are plotted in Fig. 1 and the two atypical scales, clinical cases and seventh grade remedial readers of average intelligence, are plotted in Fig. 2. Preschool and adult-seniors scales have also been included in Fig. 2 so that adequate comparisons can be made.

Results of the Unidimensional Scale Analysis

The scales in Figs. 1 and 2 can be interpreted within a frame of zero and 100. A scale score of zero would indicate that every subject in the group saw that particular error type as least similar to the target word. A score of 100 would indicate that, in every comparison involving the particular error, each subject chose that particular category as most similar to the target. Both the adults and college seniors have very low scale scores for Reversals (13 and 17) and high scores for Additions (79 and 80) indicating a consistent choice behavior for the group over these two kinds of visual errors.

Figure 1 graphically compares the four groups of normal subjects. One interesting result concerns the scale scores of these groups on Reversals and First to Last. On these two error categories the error preference is ordered by age. Adults and college seniors show the least tolerance for severe permutations of the letters while preschoolers show the greatest relative preference for such errors. The other groups' scores are also ordered by age and fairly evenly spread within the two extremes.

This ordering is reversed, however, for Addition errors. Thus the preschool children see the least amount of similarity between Addition error-words and the target words. The preschool children are also somewhat low, in comparison with other groups in their tolerance for errors of adjacent letter transposition (Permutations) and show a definite preference for Deletions.

The profiles of the three older groups are similar and differ in terms of the degree of tolerance for the errors more than in any other way. In each error category the error preferences are ordered by age. Adults, for example, least tolerate Rotations while 2-3 graders have the highest scale scores for that category. The scale scores for change in letter order have been reversed in Figs. 1 and 2 to illustrate the preference trend by age.

Figure 2 illustrates the similarity between the profile of the eight children with severe reading problems and the preschool profile. The only large differences between these two groups occurs in the category of Misperceptions and Reversals. Since an item analysis shows that the scoring for Misperceptions is open to question, further work is needed to confirm whether the clinical group sees pseudowords containing Misperception errors as most similar to the targets. Figure 2 also shows that the seventh grade remedial readers with normal IQs have a profile that is very similar to both the fourth grade students profile ($r = .91$) and the adults-college seniors profile.

Individual profiles obtained from the E-WPI show wide variability between subjects within any one group but are less variable as age increases. While the adults and college seniors had generally low scores for Reversals

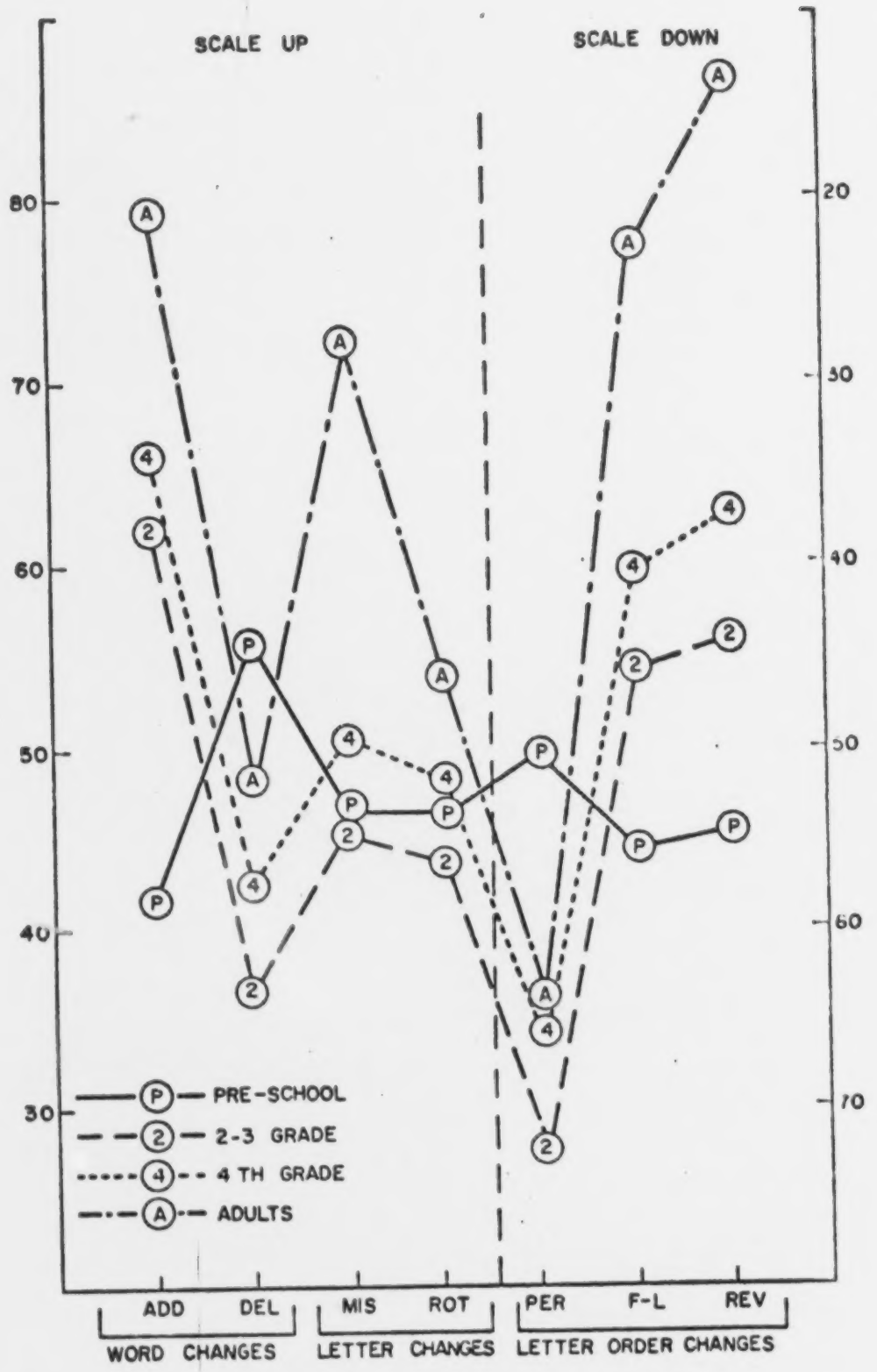

FIG. 1 -- FOUR NORMAL GROUPS RELATIVE PREFERENCE FOR MATCHING ERROR-WORDS IS SHOWN. SCALE SCORES FOR LETTER ORDER CHANGES HAVE BEEN REVERSED TO ILLUSTRATE THE TREND FOR DIFFERENT AGE GROUPS.

and First to Last errors there were three adults who had relatively high scores in these two categories.

Forty-eight of the 52 adults were retested one month after the initial testing. The test-retest correlation (.88) indicates that such error-word preferences are fairly stable in the adult population.

Item Analysis

The responses of 30 college seniors and 44 below average readers in the second and third grade were used to test the discrimination ability of each item in the E-WPI. The teachers of the elementary school children were asked to choose children in their classes who they felt were reading below grade level. These students were designated as below average readers.

Responses to each item were categorized in a four-fold table in which college seniors and elementary-school below average readers constituted one dichotomy, and first or second error-word formed the other. Phi coefficients (Peason's r for dichotomous data) found between group membership and error-word choice served as discrimination indices. Table 2 presents a rank ordering of the items of the E-WPI based on the magnitude of this index.

By way of example, consider item 52 (the second item in Table 2). The target word is slow, and the two error-words are lows and slo. The discrimination index is -0.626. The negative value indicates that seniors preferred the second error-word (slo) more often than the elementary school children preferred it. The absolute magnitude of -0.626 indicates that difference between the two preference levels is large.

The signs of the discrimination indices can be predicted remarkably well by using the following order:

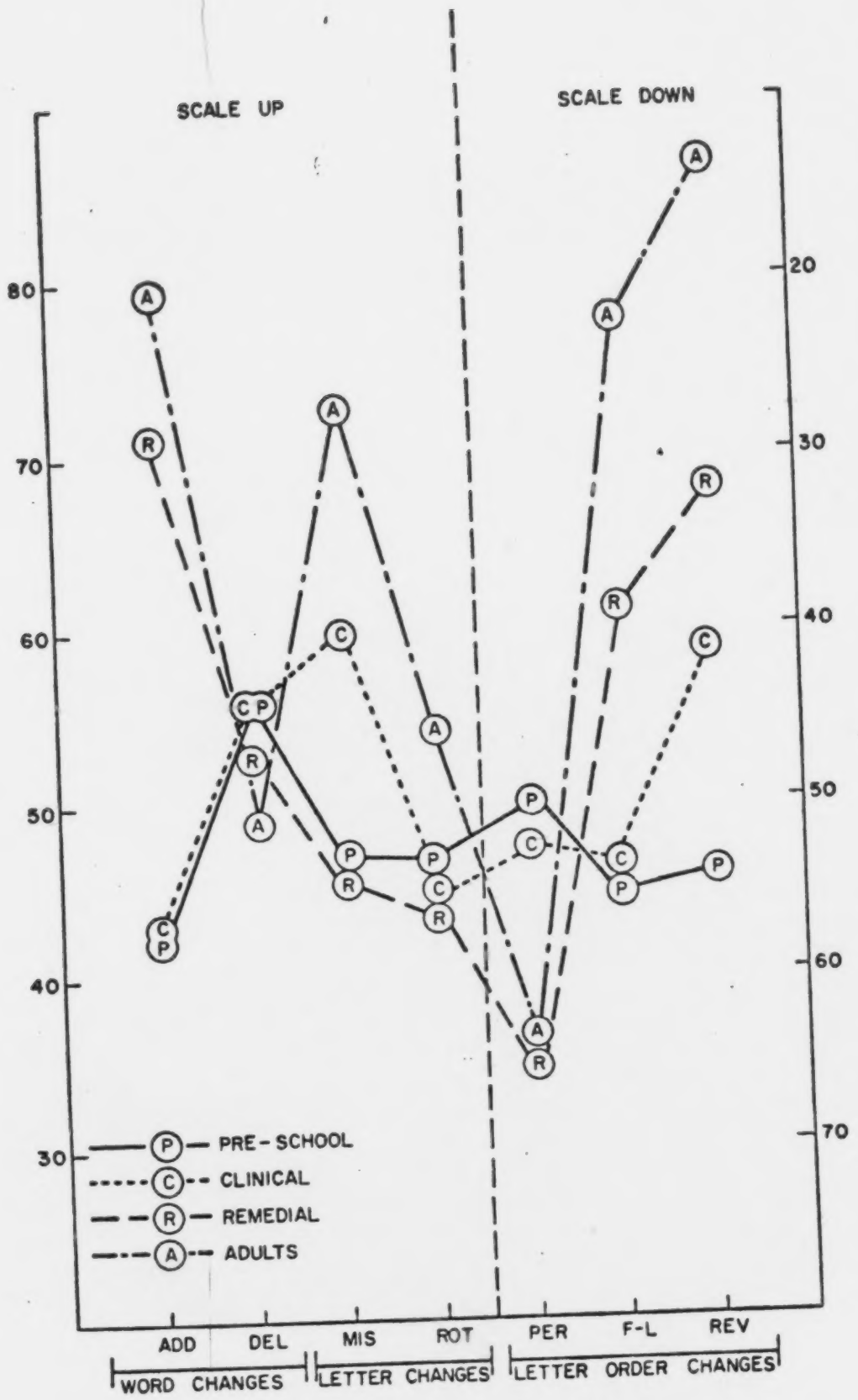

FIG. 2 -- CLINICAL CASES AND 7 TH GRADE REMEDIAL READERS ARE COMPARED WITH PRE-SCHOOLERS AND ADULTS IN PREFERENCE FOR MATCHING ERROR-WORDS. SCALE SCORES FOR LETTER ORDER ERRORS HAVE BEEN REVERSED.

Additions
Deletions
Misperceptions
Rotations
Permutations
First-to-Last
Reversals

With only 5 exceptions, the seniors prefer the earlier category of any pair more strongly than the elementary school children do. (The 5 exceptions, which are indicated by the mark #, in Table 2 all have discrimination indices of small magnitude.)

The magnitude of the discrimination between the error categories also depends upon factors such as the similarity and position of the letters utilized, expecially when misperceptions and rotations are used. Thus item 50:

50:

clue → cluo (MIS)
clue → cleu (PER)

failed to discriminate while in a similar comparison item 8;

case → acse (PER)
case → oase (MIS)

is an important discriminator primarily because the errors are embedded at the beginning of the word.

Just over half (34) of the items were significant discriminators. (The probability of a correlation as large as .23 is less than .05 by chance.) After Table 3 was constructed, five of the items were found to be misclassified. These misclassifications indicated by a * in Table 2 occurred with items 2, 6, 23, 37, and 58. Four of the items contain a substitute for a misperception error and in all four of these cases a rotation error was

substituted for a misperception. Thus the similarities shown by the subjects between rotations and misperceptions may be partially due to these misclassifications.

It is interesting to note that most of the misclassifications occurred primarily as errors in typing the inventory and were not caught during proof-reading. A second source of misclassifications occurred because it was difficult to decide whether the similarity between (a-e) was due to a rotation or misperception or both. A decision was finally made to call this a rotation instead of a misperception.

None of the misclassified items pairs a rotation against a misperception. It is doubtful, therefore, that much difference in scoring occurred since these two kinds of error items, as presently constituted, are very similar and comparisons between these two categories and all the other error types were very similar.

MDPREF Analysis

MDPREF is a computer program (Chang and Carroll, 1968) which does a linear factor analysis and yields subject vectors (whose coordinates are factor scores) and stimulus vectors (whose coordinates are factor loadings). The output of this program plots both the stimuli and the subjects in the same plane.

One MDPREF analysis was performed on above average subjects in preschool, second, and fourth grades and on college seniors. A second analysis was also found for above and below average readers in grades three and four. In addition the clinical cases; below average readers in the second, third, and fourth grades; and remedial readers responses were analyzed together. The results of the first two analyses are plotted in Figs. 3, 4, and 5.

Table 2

Rank ordering of the items in the E-WPI based on their ability to discriminate between college seniors and below average readers in the second and third grade

Item No.	Target Word	Error-Words First		Second		Discrimination
8	case	acse	(Per)	oase	(Mis)	-.651
52	slow	lows	(F-L)	slo	(Del)	-.626
10	thaw	hawt	(F-L)	haw	(Del)	-.533
27	like	liike	(Add)	ikel	(F-L)	.495
36	went	wnet	(Per)	wennt	(Add)	-.464
3	some	emost	(Rev)	ssome	(Add)	-.454
7	foal	oalt	(Del)	loaf	(Rev)	.439
* 6	take	ttake	(Add)	ekat	(Rev)	.436
15	neat	enat	(Per)	nneat	(Add)	-.422
28	back	bak	(Del)	kcab	(Rev)	.422
21	fade	tade	(Rot)	adef	(F-L)	.398
49	miss	mis	(Del)	ssim	(Rev)	.398
44	some	omes	(F-L)	somc	(Mis)	-.379
24	town	nwot	(Rev)	toown	(Add)	-.376
* 2	mare	arem	(F-L)	uare	(Rot)	-.367
53	bear	raeb	(Rev)	bera	(Per)	-.363
38	jump	juwp	(Rot)	pmuj	(Rev)	.348
* 58	race	raca	(Rot)	rac	(Del)	-.346
14	blow	wolb	(Rev)	lowb	(F-L)	-.340
43	self	sefl	(Per)	selt	(Rot)	-.337
19	cool	ccool	(Add)	ool	(Del)	.329
11	warm	mraw	(Rev)	awrm	(Per)	-.317
25	come	cme	(Del)	cmoe	(Per)	.309
35	nest	tsen	(Rev)	estn	(F-L)	-.299
17	door	boor	(Rot)	rood	(Rev)	.289
26	made	mahe	(Mis)	mape	(Rot)	.279
41	love	lave	(Mis)	evol	(Rev)	.278
*37	snow	suow	(Rot)	snw	(Del)	-.278
61	sail	saill	(Add)	sai	(Del)	.267
45	slim	mils	(Rev)	slimm	(Add)	-.258
31	park	arkp	(F-L)	pak	(Del)	-.247
47	high	hign	(Mis)	higy	(Rot)	.236
48	cape	capee	(Add)	apec	(F-L)	.2333
59	shop	shog	(Mis)	pohs	(Rev)	.233
60	rare	arer	(F-L)	raer	(Per)	-.222
63	grow	grom	(Rot)	rowg	(F-L)	.219
32	sway	yaws	(Rev)	sawy	(Per)	-.214
20	coat	eoat	(Mis)	taoc	(Rev)	.204
22	gone	gnoe	(Per)	goue	(Rot)	-.199
46	bare	bar	(Del)	baer	(Per)	-.197
*23	kite	itek	(F-L)	kife	(Rot)	-.188
56	care	erac	(Rev)	arec	(F-L)	-.187
62	surf	sufl	(Mis)	frus	(Rev)	.170
42	mark	merk	(Rot)	arkm	(F-L)	.166

Table 2 continued

Item No.	Target Word	Error-Words First		Second		Discrimination
29	cone	cnoe	(Per)	cene	(Mis)	-.159
39#	face	acef	(F-L)	fcae	(Per)	.158
44	sell	ell	(Del)	esll	(Per)	.151
51	glow	glom	(Rot)	gloww	(Add)	-.147
18	flat	latf	(F-L)	lfat	(Per)	-.147
33	bake	baake	(Add)	boke	(Mis)	.146
30	came	cawe	(Rot)	caame	(Add)	-.142
9	then	fhen	(Rot)	tthen	(Add)	-.138
57	game	gaem	(Per)	gamee	(Add)	-.131
12	them	tthem	(Add)	lhem	(Mis)	.124
5#	cake	oake	(Mis)	uake	(Rot)	-.103
13	cost	ost	(Del)	uost	(Rot)	.070
34	some	som	(Del)	sowe	(Rot)	.066
40	mast	maast	(Add)	mst	(Del)	.055
1#	blue	lbue	(Per)	dlue	(Rot)	.037
54#	with	withh	(Add)	witn	(Mis)	-.032
55#	soon	soo	(Del)	soou	(Rot)	-.031
50	clue	cleu	(Per)	cluo	(Mis)	-.016
16	trap	lrap	(Mis)	rap	(Del)	-.005

*Error-Word was found to be misclassified.

#Exception to preference transitivity.

The MDPREF Analysis revealed one major and two minor dimensions in each of the three groups responses to the items of the E-WPI. The dimension loadings of the stimuli for the three analyses cited are presented in Table 3.

TABLE 3

Dimensional loadings for three separate MDPREF analyses of subjects scores on seven visual errors.

	Dimensions								
	Above Average Readers			3 & 4 Grade			Poor Readers		
	I	II	III	I	II	III	I	II	III
Additions	626*	244	-221	605	274	499	-505	289	600
Deletions	148	-411	-660	299	-530	261	-201	-507	282
Misperceptions	120	-398	449	057	-218	-511	-216	-248	-485
Rotations	316	-344	475	181	-212	-476	-171	-213	-404
Permutations	121	685	226	-034	739	-268	-012	742	-300
First to Last	-462	111	-148	-465	016	262	451	-015	071
Reversals	-582	112	-121	-573	-069	233	652	047	235
% Variance	55.8	24.4	13.9	44.5	28.3	14.0	40.7	29.7	14.3
Cumulative	55.8	80.2	94.1	44.5	72.8	86.8	40.7	70.4	84.7

*Decimal Points have been omitted.

The three dimensions can be generally described as follows:

Dimension I - Maximum change in letter order vs. no change in letter order. In this factor Additions, which preserve the order of the letters and thus preserve the "integrity" and continuity of the word, are contrasted

with Reversals and First to Last errors which make radical changes in letter order.

Dimension II - Small changes in letter order vs. word changes. In this factor Permutations, which are adjacent letter transpositions and therefore reflect less drastic changes in letter order, are contrasted with Deletions which alter the word by reducing its length.

Dimension III - Letter distortions vs. changes in word length. Dimensions III contrasts the letter distortions that occur under Misperceptions and Rotations of the letters with the error of Additions. In this factor no changes in letter order are present and the Misperceptions and Rotations reflect only small changes in word shape.

Results of the MDPREF Analysis

Figure 3 illustrates the dominance of the college seniors preference for Addition errors as opposed to error words containing severe changes in letter order. The large variance of the college seniors positions on Dimension II indicates tolerance for small changes in a word but an indication that maintaining the general order of the letters is an important factor in their preference.

The fourth grade students have almost reached the preference position of the adults. The diagram suggests that normal fourth grade students are viewing words in much the same way as adults but are slightly more permissive of order changes.

Some second grade students, however, appear to concentrate on the letters of the word in determining similarity. Their preferences for Permutations, Reversals, and First to Last error is demonstrated. They

are quite variable, however, and approximately half the second grade students are approaching the adult pattern and show a preference for addition errors.

The preschoolers show a definite lack of preference and some of their choices appear to be made at random. Those that do show some consistent choice behavior prefer the severe letter order distortions of Reversals and First to Last.

Figure 4 illustrates that the differences between above and below average readers in the third and fourth grade may be ones largely of degree. This comparison involved students nominated by their teachers as being above or below average readers. Since every subject in the third and fourth grade at the Hahaione Elementary School was dichotomized a large degree of overlap between the two groups is not surprising.

The below average readers show a greater variance in their choices and could be generally described as not being as consistent as the better readers in their preference choices. They also have a higher relative preference for Permutation errors. There appears to be a small but definite cluster of both kinds of readers in the third and fourth grade who show a preference for severe letter changes as opposed to other kinds of errors.

Figure 5 illustrates above and below average third and fourth grade subjects positions with regard to Dimension I and Dimension III. Dimension III: letter distortion vs. word distortions, appears effective in separating these two groups of children. The poorer readers shy away from the distortion offered by Deletions and take a more letter dominated view of similarity. It can be easily seen that the difference between Dimension

II and Dimension III lies in how Permutations and Deletions reverse their positions. Dimension III re-emphasizes the transitivity observed in Table 2 as a guide for discrimination between good and poor readers.

Discussion of the E WPI

An analysis of subjects responses to the Visual Profile Inventory suggests that the inventory measures a property of spatial organization which varies widely in the population and may, therefore, be an effective diagnostic of reading difficulty. Proof of its capability awaits refinement of the inventory and administration to more clearly defined groups of subjects.

The inventory needs to be altered so that each category is uniquely and consistently represented. One might ask if it would be possible to create items for which the transitivity of discrimination shown in Table 2 is reversed. For example, in the item

month

mouth (ROT)

onth (DEL)

one would expect adults to choose "mouth" as most similar to the target, a non-transitive choice. It is doubtful, however, that such an item would discriminate between good and poor readers. It seems reasonable, therefore, to construct items within the general transitivity observed but to improve the discrimination ability of the items. The seniors choice of a Misperception over an adjacent letter transposition is dependent upon the similarity of the substituted letter and the position of both the Misperception error and the Permutation in the pseudoword.

An item that should discriminate between good and poor readers might be as follows:

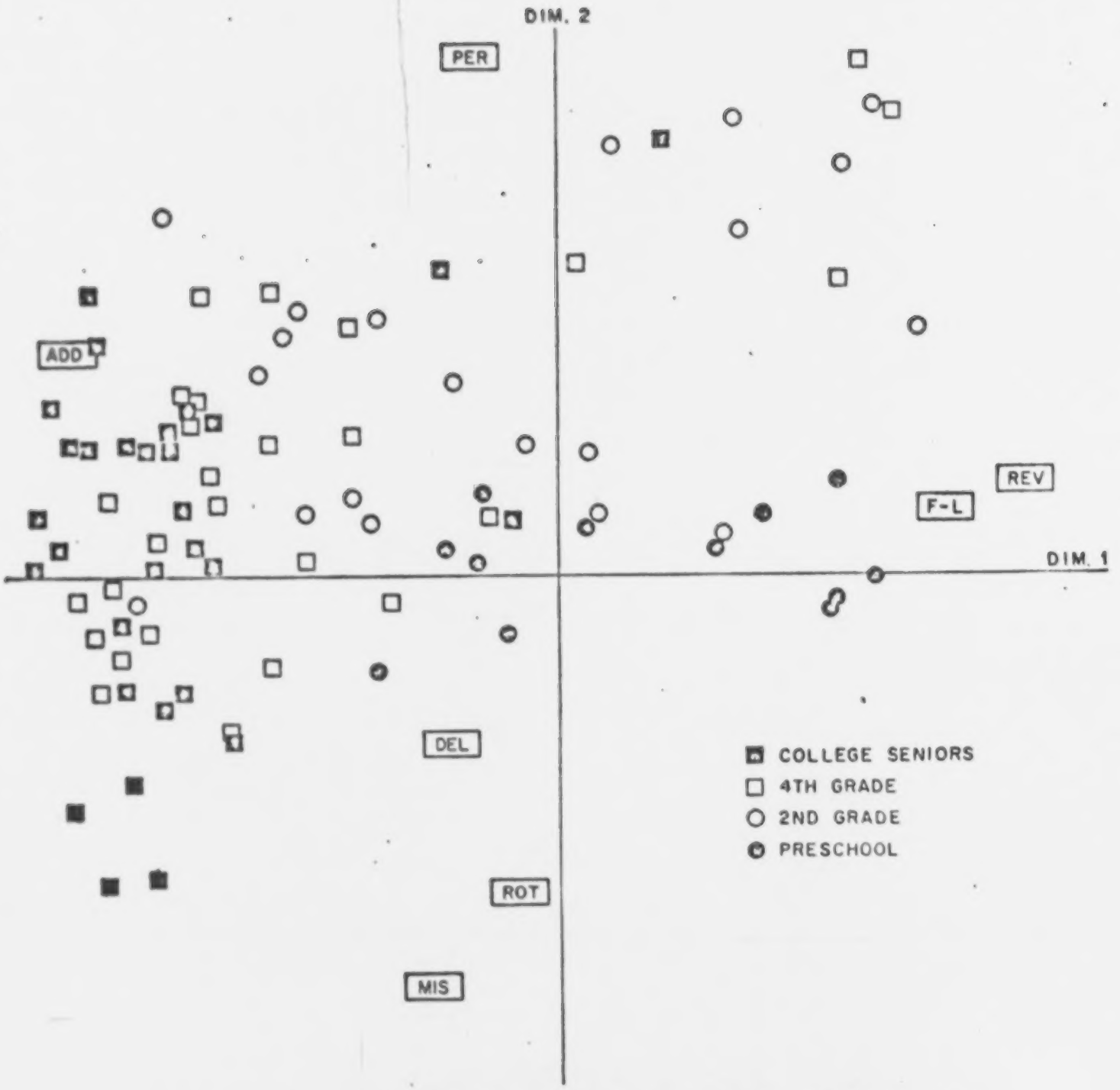

FIG. 3 PRESCHOOL, SECOND, AND FOURTH GRADE CHILDREN AND COLLEGE SENIORS ARE PLOTTED IN THE SPACE FORMED BY DIMENSION 1 (MAXIMUM CHANGE IN LETTER ORDER VS. NO CHANGE IN LETTER ORDER) AND DIMENSION 2 (SMALL CHANGE IN LETTER ORDER VS. WORD DISTORTION) BASED ON THE MDPREF ANALYSIS OF SEVEN WORD ERRORS.

cart — eart (MIS); acrt (PER)

In this item the more adult reader should choose "eart" because there is minimal distortion between c and e and because good readers like to preserve the "integrity" of the word, i.e., one that keeps the elements in the proper order.

Preservation of the observed transitivity should provide a means of creating discriminating items for other pairings in which indices were low. Table 2 shows, for example, that there were no significantly discriminating items which compared Misperceptions with Additions. Items 12 (PHI = .146) and 33 (PHI = .124) were as follows:

(12) bake — baake (ADD); boke (MIS)

(33) then — tthen (ADD); lhen (MIS)

Minimal distortions of the target word occur in these two cases in which letter substitutions with high similarities are made. It seems reasonable, therefore, that an item such as the following might be more discriminating:

sore — oore (MIS); ssore (ADD)

since o is not highly similar to s.

Discussion of Results

This initial investigation indicates that for most people reading styles change as they mature. This change is from an individual "letter conscious" view of words to one in which the "order of the letters" is a

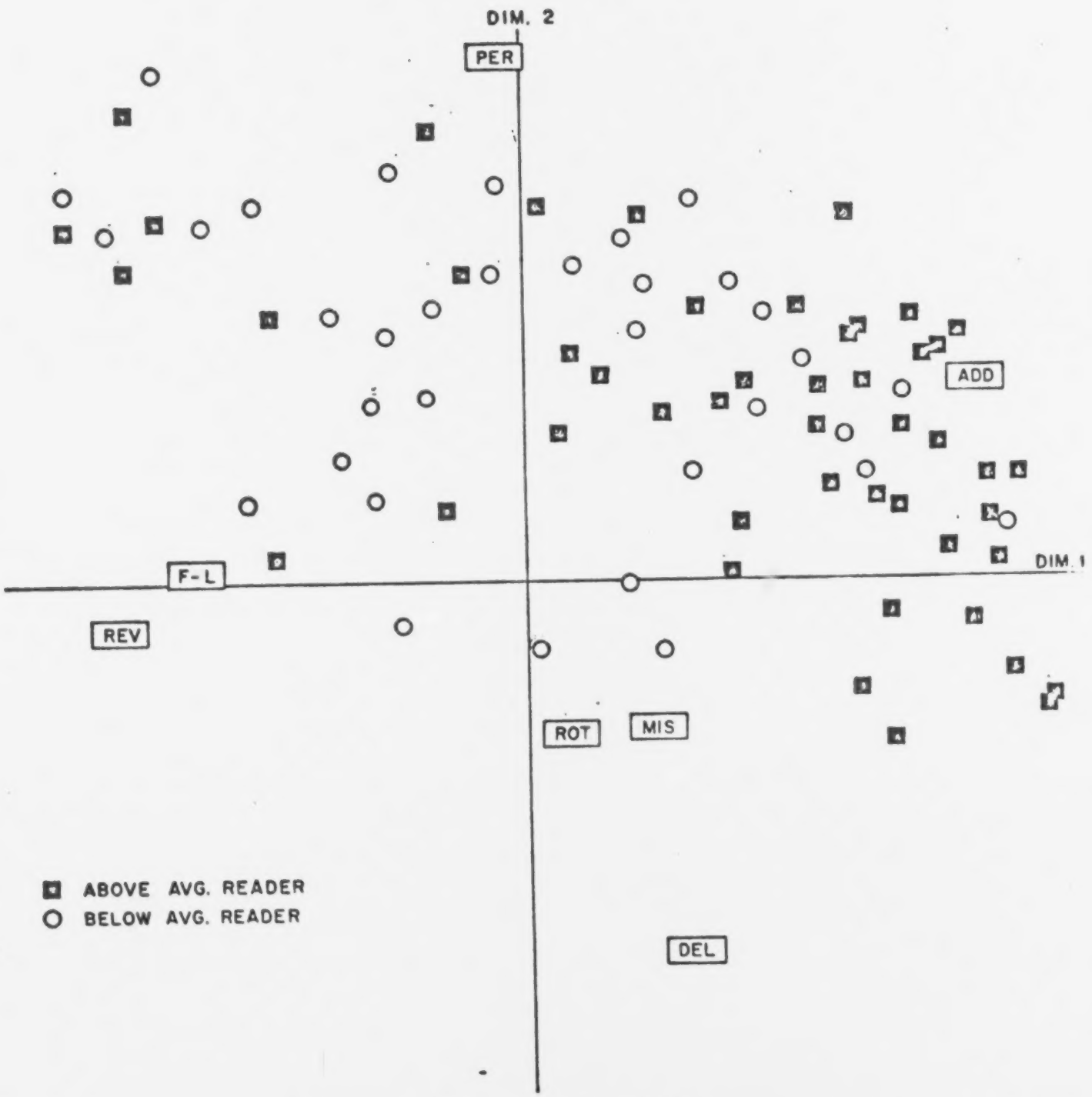

FIG. 4 - ABOVE AND BELOW AVERAGE READERS IN THE THIRD AND FOURTH GRADES ARE PLOTTED AGAINST DIMENSION 1 (MAXIMUM CHANGES IN LETTER ORDER VS. NO CHANGE IN LETTER ORDER) AND DIMENSION 2 (SMALL CHANGE IN LETTER ORDER VS. WORD DISTORTION).

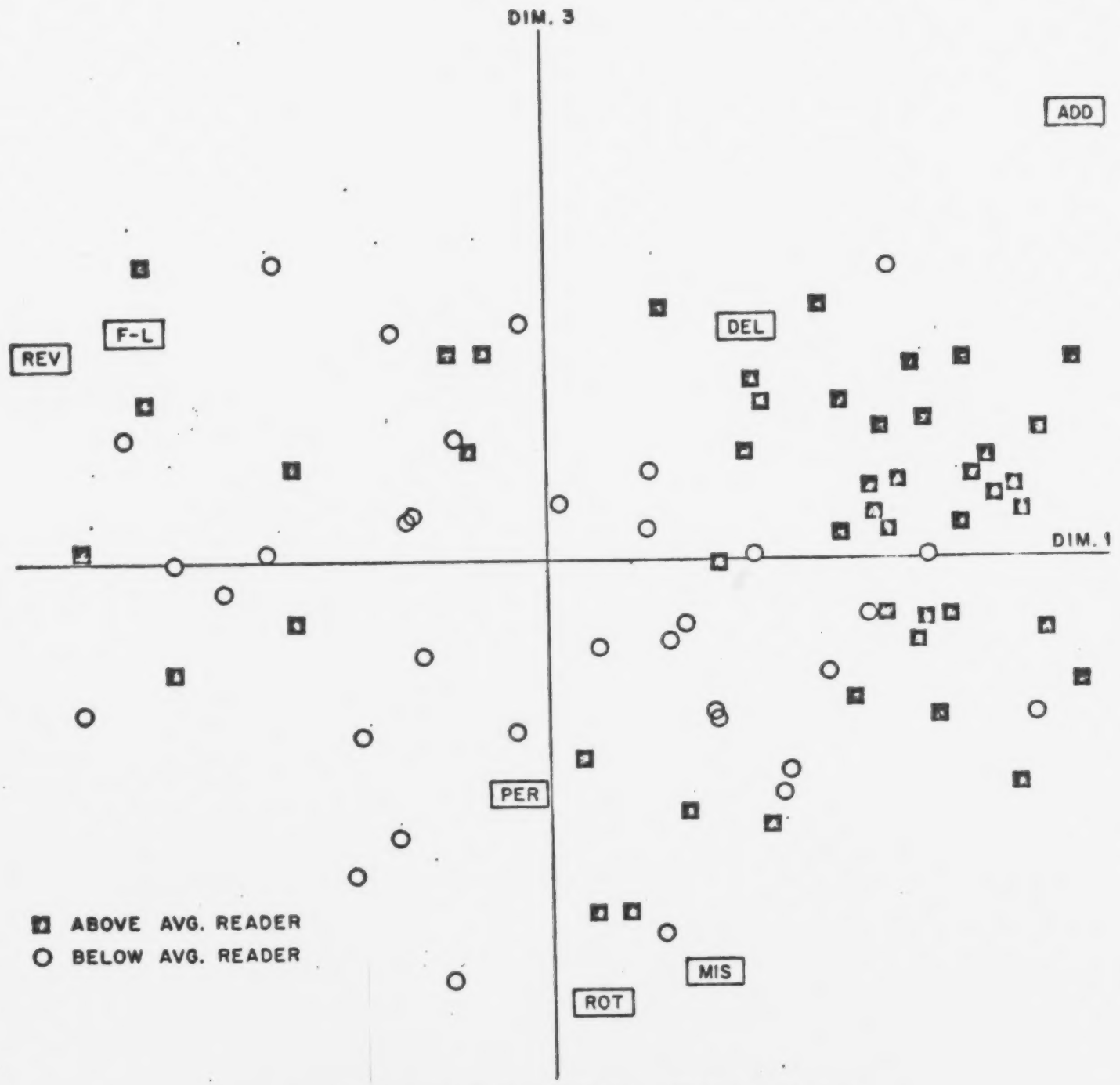

FIG. 5 – ABOVE AND BELOW AVERAGE READERS IN THE THIRD AND FOURTH GRADES ARE PLOTTED AGAINST DIMENSION 1 (CHANGE IN LETTER ORDER VS. NO CHANGE) AND DIMENSION 3 (LETTER DISTORTIONS VS. CHANGES IN WORD LENGTH)

more important factor in reinforcing the subject's expectation of what is printed. One explanation for these results is that space orientation is not well established for beginning and early readers. In addition, the young child's limited experience with words limits the use of context clues as an aid in word identification. Thus the cues for word recognition are predominately the visual symbols presented and the young reader is forced to concentrate on the individual letters which form the word in order to make its identification. On the other hand, the general preference of seniors and good readers in the fourth grade for Addition errors over Reversals seems related to the better readers preference for a left to right scanning of the word. Thus extreme letter changes are more disturbing to him than other kinds of word distortions. They appear to interrupt the "guessing confirmation" game we know as reading.

Consistency of choice also appears developmental. A lack of consistent choice behavior can be postulated for both the preschool children and the clinical cases. Older children show more consistency in their individual profiles and this is reflected in the group profiles which are ordered by age.

Contrary to the usual pattern, a few good elementary school readers have profiles with consistent preferences for pseudowords whose letters, while permuted, are the same as the target, i.e., Reversals. It is suggested that these subjects may be able to solve the reading problem with a consistent "letter conscious" reading style. The author has also observed in a statistics class that a few very good graduate students were relatively high in their preference for First-to-Last and Reversal error-words. F-L and REV are related to a skill which is useful when using the commutative

law for mathematics, i.e., abc = bca. One could argue that the very best readers are ones that are consistent or are able to change their reading style to fit the material or both.

For normal readers there appears to be a general trend toward the adult preference as children progress upward through the elementary school. It is hypothesized that as children gain spatial orientation, as they learn the mechanism of scanning from left to right, as they come to know what order means, and as they gain in experience and thus in their ability to use context clues their preferences tend to become more like those of adults.

The study supports the contention that young children and adults use different methods in attacking and reading words but that most children change to an adult style of word perception by the end of the fourth grade.

Acknowledgment

The author wishes to thank J. B. Kruskal for his careful reading and many helpful comments and suggestions.

1.

Name_____

Sex_____

Age_____

Grade_____

Date_____

In every block be sure you circle one word of each pair that is most like the single word. DO NOT SKIP ANY PAIRS!

1	blue	lbue dlue
2	mare	arem uare
3	some	emos ssome
4	sell	ell esll
5	cake	oake uake
6	take	ttake ekat
7	foal	oal laof
8	case	acse oase
9	then	fhen tthen
10	thaw	hawt haw
11	warm	mraw awrm
12	them	tthem lhem
13	cost	ost uost
14	blow	wolb lowb
15	neat	enat nneat
16	trap	lrap rap
17	door	boor rood
18	flat	latf lfat
19	cool	ccool ool
20	coat	eoat taoc
21	fade	tade adef

2.

Name_____

Sex_____

Age_____

Grade_____

Date_____

In every block be sure you circle one word of each pair that is most like the single word. DO NOT SKIP ANY PAIRS!

22	gone	gnoe goue	31	park	arkp pak
23	kite	itek kife	32	sway	yaws sawy
24	town	nwot toown	33	bake	baake bake
25	come	cme cmoe	34	some	[illegible]
26	made	mahe mape	35	nest	[illegible]
27	like	liike ikel	36	went	[illegible]
28	back	bak kcab	37	snow	[illegible]
29	cone	cnoe cene	38	jump	[illegible]
30	came	cawe caame	39	face	[illegible]
			40	mast	[illegible]
			41	love	[illegible]
			42	mark	merk [illegible]

3.

Name_____

Sex_____

Age_____

Grade_____

Date_____

In every block be sure you circle one word of each pair that is most like the single word. DO NOT SKIP ANY PAIRS!

43	self	sefl selt
44	some	omes somc
45	slim	mils slimm
46	bare	bar baer
47	high	hign higy
48	cape	capee apec
49	miss	mis ssim
50	clue	cleu cluo
51	glow	glom glovw
52	slow	lows slo
53	bear	raeb bera
54	with	withh witn
55	soon	soo soou
56	care	erac arec
57	game	gaem gamee
58	race	raca rac
59	shop	shog pohs
60	rare	arer raer
61	sail	saill sai
62	surf	sufl frus
63	grow	grom oug

APPENDIX B

Scale scores of relative preference for matching words containing seven major kinds of letter errors.

Group	N	REV	F-L	PER	ROT	MIS	ADD	DEL
Preschool	12	55	56	51	46	46	41	[illegible]
2nd Grad	49	44	42	72	44	46	63	[illegible]
2-3 Grade	41	41	47	71	46	47	62	[illegible]
3rd Grade	37	48	52	75	40	42	58	[illegible]
4th Grade	45	38	41	66	48	50	65	[illegible]
Coll. Seniors	30	17	28	61	51	58	80	[illegible]
Adults	52	13	21	66	55	72	79	[illegible]
Rem. Readers	25	33	40	66	43	45	70	[illegible]
Clinical Cases	8	42	54	53	44	59	42	[illegible]

Pearson r correlations between group scale scores over seven error categories.

	PS	2	2-3	3	4	CS	A	RRR	[illegible]
Preschool		-44	-45	-11	-67	-77	-84	-52	[illegible]
2nd Grade			97	90	93	57	59	81	-14
2-3 Grade				92	93	55	59	77	-08
3rd Grade					72	22	24	58	-09
4th Grade						81	83	91	-08
College Srs.							95	88	06
Adults								77	12
Remedial 7th									-02
Clinical Cases									

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